

Social processes in the geography of soils: gender and soil quality in SW Hungary

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Understanding the social causes of anthropogenic changes in soils can improve explanations of soil spatial distributions. Soil geography largely ignores the social relations behind human impact. Similarly, research on social processes related to soil degradation typically excludes analyses of soil dynamics. A study was conducted in SW Hungary to investigate the interrelationship between soil quality (selected pedochemical indicators) and social relations by focusing on gendered land use processes. Through semi-structured interviews, soil sampling, and archival research, I found that gendered farming resource access and control affects the spatial variability of soil characteristics within the same soil type. Contrary to some current views, greater gender inequality within households does not necessarily translate into less sustainable soil management practices. The outcomes of social relations are not coterminous with specific forms of soil quality change because of multiple soil property determinants, the context-dependence resulting from social and (wider) ecological processes co-occurring at multiple scales, and the multiplicity of human and nonhuman factors involved in the making of local soil quality. Nevertheless, gender relations give rise to determinate forms of land use that shape the spatial distribution of soil characteristics, which relate dialectically to the internal processes of farming households. Understanding social processes together with soil dynamics is therefore important in explaining the geography of soils (and intra-household processes) and in developing socio-ecologically viable uses of soils.

Keywords: gender, human-environment relations, land use, Hungary, soils

Introduction

Soil geography entails describing and explaining the development and distribution of soils (Bridges, 1981). The importance of such an endeavor can be encapsulated by the recent remarks of Scull et al., who stress that “Understanding the spatial distribution and management of soil is critical to maintaining a productive society and to understand the complex balance of chemical and physical processes that make life possible on Earth” (Scull et al., 2003, 171-172). Arguably, this understanding must involve a thorough consideration of social processes in addition to nonhuman processes, especially if one is to capture soil property heterogeneity at detailed scales (Barrett, 1999, 709). Studying social processes should be crucial to soil geography because human activities constitute a major factor affecting soil-forming processes (additions, removals, transformations, translocations) for millennia at least. They now exert, historically and on aggregate, unparalleled effects on wider ecosystem processes, such as nutrient cycling and human’s very ability to procure or produce food and settlement infrastructure (Brown, Huddleston, and Anderson, 2000; Lal, 1998; Markewitz and Richter, 2001).

Yet despite a vast literature on anthropogenic soil change spanning more than a hundred years, standard approaches fail to incorporate social relations, the very source of human impact, as part of causal mechanisms (Scoones, 2001, 13; Yaalon and Berkowicz, 1997; Warkentin, 2006)¹. This epistemological problem persists despite numerous studies showing that people-environment interactions are influenced by (spatio-temporally shifting) socially differentiated resource access, control, and use (cf., Blaikie, 1985;

Bryant and Baily, 1997; Castree and Braun, 2001; Dankelman and Davidson, 1988; Robbins, 2004; Zimmerer, 1993). Critical approaches to anthropogenic environmental change have also enhanced this understanding by highlighting the gender-specificity of environmental practices and exposure to environmental change (cf., Cronon, 1983, 34-53; Harris, 2006; Merchant, 1989; Nightingale, 2006; Reed and Mitchell, 2003; Rocheleau, Thomas-Slayter, and Wangari, 1996; Sachs, 1997; Salleh, 1997; Schroeder, 1999; Seager, 1993). These advances in understanding human-induced environmental change, including through feminist research, have rarely transferred to the study of biophysical processes (Banerjee and Bell, 2007; Neumann, 2005), and soil geography is no exception. On the other hand, studies of anthropogenic environmental change that address social processes such as gender, including political ecologies, rarely entail analyses of biophysical processes (Walker, 2005; Zimmerer and Bassett, 2003; for some examples, see Leach and Mearns, 1996; Zimmerer and Young, 1998), much less of soil dynamics. Investigations sensitized to social theories and/or processes are largely confined to showing the social impact of soil degradation, thereby missing the opportunity to examine the pedological effects of social relations and, even more importantly, the mutual influence of soil dynamics and social relations over time.

This article explores the gendered character of anthropogenic effects on agricultural soil quality in an area of SW Hungary to demonstrate how a soil geography that grapples with context-specific social relations can help explain at least some pedochemical aspects of soil variability. Specifically, the study is an inquiry into whether and how the gender-differentiated access to farming resources combined with gender-specific land use practices lead to gender-specific impacts on soil characteristics. This is accomplished through a case study using an intensive research design (Burawoy, 1998; Hamel, Dufour, and Fortin, 1993; Richards, 1996; Sayer, 1992) and by combining semi-structured interviews with soil sample analysis (Anonymous, 2000; see also Feldstein and Jiggins, 1994). I examine the relationship between individuals' gendered social position, environmental practice (e.g., cropping system, agricultural inputs), and soil properties at the household scale to explain soil quality differences among cultivated plots on the same soil type².

After explicating the theoretical basis of this study and describing the case study area and methods, the article proceeds with describing and explaining the relationship between gender, environmental practice, and soil status. The linkage is first contextualized through an analysis of local gender divisions of labor, while the actual processes of soil use are then examined through the experiences of three farming households. Soil use histories and farm-level gender relations are discussed for each household to interpret soil sample analysis results. Additional discussion is devoted to the case of plot cultivation abandonment in the case of households that do not use soils for cash-crop production. Finally, I explore soil dynamics and gendered differentiation within farming households as reciprocally affecting process.

The findings indicate that soil management is gender-specific, owing to gender divisions of work and access to farming resources, and that gender-differentiated practices help explain soil quality differences between subsistence plots and cash-cropped fields for several pedochemical indicators. Gender-based environmental practices result in contradictory tendencies in environmental practices and soil characteristics in

subsistence plots, in a context of industrialized farming in the wealthier semiperiphery. Changes to soil quality also affect the internal structuring of farming households, which, at the same time, lead to modifications in land use and other soil-altering activities that give rise to further soil quality change. Gender relations should be therefore considered as a major causal factor in the heterogeneous spatial distribution of soil-type characteristics.

Soil dynamics, agricultural land use, and gender relations

Soil formation and spatial variability result from both the interaction of environmental factors (climate, organisms, topography, parent material) over time and resultant intrinsic properties (Buol, 1990; Gerard, 2000; Phillips, 2001). These interactions and soil characteristics have been increasingly affected by human activities, often in destructive pedodiversity-reducing ways (e.g., mountain-top removal in West Virginia uplands for coal extraction)³. Though considered in many studies of changes in soil dynamics, the pedological impact of human activities is largely studied in terms of soil degradation and seldom analyzed beyond a consideration of physical landscape factors and changes in land use, segmented according to activities such as cultivation, pastoralism, forestry, and urban and industrial uses (Ellis and Mellor, 1995, 221-235; Fullen and Catt, 2004, 8, 199-200). Otherwise, human impact on soils has been explained as the result of farming poor soils, demographic pressures, poverty, and/or inappropriate farming practices, all at the local level (cf., Koning et al., 2001; Lal, 1998; Lal and Pierce, 1991; Ravnborg, 2002).

Though valuable contributions, these explanations do not consider the social determinants of land use themselves even though land use is an outcome of social relations at the interface of soil system dynamics (polypedons, tesserae, catenas, etc.). A lack of understanding of social determinants leads to crucial misrepresentations of causal factors by, for instance, treating land use as if it caused soil change. Yet it is social activities, based on particular sets of social relations, which cause diverse forms of land/soil use practices affecting soil development. In other words, the social relations that cause land use decisions are understudied or, worse, ignored in this literature, thereby reducing the explanatory depth of theories on soil formation and variability. Given the current importance of anthropogenic factors, soil geography should include the analysis of social relations, at least for soil properties varying from sub-decadal to centennial timescales. After all, under the currently prevailing global political arrangements, we interact as socially stratified organisms with(in) ecosystems at multiple scales, differentially changing and being changed by the environments we inhabit. For a more meaningful analysis of soil management, the concept of land use should be extended to include the social context involved, as some researchers have been doing for other objects of study (among others, Atkinson, 1991; Bryant and Baily, 1997; Denevan, 2001; Lambin et al., 2002; Lima et al., 2002; Norton et al., 2003; Richter and Markewitz, 2001; Smith, 1980; Veeck, Zhou, and Ling, 1995; Vitousek et al., 2004; Zimmerer and Bassett, 2003).

A variety of scholars, especially geographers employing a political ecology framework, have also critiqued these kinds of explanations for failing to consider multiple scales, national and international economic pressures, historical context, and the effects of the marginalization of local knowledge systems in development projects and for failing to explain local demographic shifts (especially in terms of labor shortages), cropping system selection, and differential resource access and control. These studies in

political ecology have demonstrated that larger-scale structural demands pressure local resource users into environmentally destructive practices (contrary to the claims of Lambin et al., 2002), that some local actors' environmental practices relate to their ability to take advantage of multiple-scale dynamics, that diverse discourses affect environmental practices (e.g., shifting soil classification, perceptions of soil degradation), and that local social relations and ecological processes can play major roles in the implementation of environmental policies (Bebbington and Batterbury, 2001, 373-374; Bell and Roberts, 1991; Blaikie, 1985; Blaikie and Brookfield, 1987; Brookfield, 2001; Grossman, 1997; Leach and Mearns, 1996; Phillips-Howard and Lyon, 1994; Scoones, 1996, 1997; Scoones and Toulmin, 1998; Stocking, 1996; Zimmerer, 1993). Overall, the above more encompassing approaches have greatly improved explanations of society-environment relations with respect to soil dynamics, but they have focused on soil degradation or pedogenic issues in non-industrialized settings and/or small-scale social systems at the expense of understanding other human-affected soil processes in other regions. Moreover, they have largely omitted internal household processes and gender relations from the analysis, in spite of their centrality to farming practices (Hovorka, 2005; Shortall, 1999; Whatmore, 1991).

Rare and buried deep within a variety of scientific fields that scarcely communicate with each other, research already exists linking the gendered character of agriculture with soil management and impact. Sachs connects some of the major global trends of soil degradation (erosion, fertility loss, contamination, etc.) to the androcentric expansion of capital, bringing increasing mechanization and intensification of land use, male monopolization of farming technologies, and marginalization of women's (often manual) work. The ensuing problems with soil degradation are differentially experienced according to gender, with women tending to be more negatively affected (Sachs, 1996, 56-65). Gender-differentiated human-induced impact on soils occurs through social processes and not as the outcome of any innate "desire to protect the soil" on the part of women (*ibid.*, 58). Women, nevertheless, play a prominent role in promoting sustainable agriculture, even if institutionalized organic farming associations feature mostly male leadership (see also Sachs, 1997; Trauger, 2004). Sachs thereby traces the soil-impacting aspect of gender-based inequalities that has been mostly ignored even in gender-environment studies. Unfortunately, these general contours of the relationship between gender relations and human impact on soils do not rely on direct empirical soils data and, in fact, they are deduced largely from studies that do not address this linkage at all. Nonetheless, findings by other authors have corroborated these tendencies to a degree.

Other studies have shown that the impacts of soil degradation and management are gendered. In the Shiwaliks region of Northern India, the privatization of communal land, concomitant ecological changes in vegetation and animal husbandry composition, and gender-insensitive soil and water conservation programs have contributed to more work for women (Arya et al., 1998). Similarly, though focusing on changing gender roles, Casey and Paolisso (1996) found that, in Honduras, soil erosion problems have risen and have mostly affected rural women as a result of their increasing work on both commercial and subsistence plots, as men seek wage-based employment following recent economic pressures. Gender roles, however shifting, have also been shown to influence soil management methods and bring about changes to soil characteristics. Millar et al.

(1996) describe women's crucial role in building and maintaining erosion control structures in Northeastern Ghana, which contributes to keeping adequate soil fertility. Women's lack of effective control over the land they cultivate may therefore undermine soil conservation. Such findings agree with Oromo (1998), who describes the social constraints women face in Kenya with respect to participation in conservation projects. The exclusionary outcomes of such constraints can reduce the effectiveness of conservation programs since many women actually practice soil conservation informally (see also Kamar, 2001; Paulson, 2003). Unlike the Kenyan context, a study from Burkina Faso shows that even in cases of women's unimpeded access to fertile land, depending on household arrangements, men tend to receive relatively higher quality land and more labor inputs (Kunze et al., 1998). Carney's study in The Gambia attests to the importance of understanding gender-specific practices and knowledge when analyzing soil degradation. Rice irrigation has been traditionally women's work, but government projects involved the transfer of pump irrigation technologies mainly to men, resulting in occurrences of acidification in coastal soils (Carney, 1991). The findings demonstrate the importance of examining gender relations as part of a set of causal factors determining soil quality change and the spatial distribution of soil characteristics.

These studies, such as the one presented here, do not necessarily furnish grounds for any linear relationship between gender relations and soil quality, although tendencies can be discerned. As many have pointed out, the outcomes of gender-based environmental practices, in contrast to Sachs' general contention, are not necessarily coterminous with the gendered results of social relations (among others, see Agarwal, 1992; Jackson, 1994; Nightingale, 2006). Soil quality improvement can occur in cases of gender-based inequality, depending on social context.

Leach and Fairhead (1995) show that, in Northern Liberia, women's subsistence production has promoted long-term soil fertility by positively transforming otherwise poor soils into soils rich in organic matter (which enhances water retention, crop nutrient content, structure, etc.). Yet such practices are entangled in historically shifting gendered resource control that is associated with increasing constraints on women. These findings concur with the results of my previous research in the same case study area described below, where, though over a much more limited area, a local patriarchal system is associated with gender-differentiated soil classification and use (Anonymous, 2002).

Although sparse, the above-cited case studies indicate that gender relations have implications for soil conditions and that, conversely, changes in soil quality affect farming community members differently according to gender. Whether gender roles are enabling or constraining, a linkage exists between gender relations and environmental practices that affects or even induces soil quality change. The matter then becomes one of understanding at what conjunctures, involving a multiplicity of social and biophysical processes, forms of gender relations give rise to higher or lower soil quality. This case study outlines the mechanisms useful to consider in a conjuncture-sensitive analysis of the interrelations of gender relations, soil use, and local soil quality distribution.

The study area

The Ormánság refers to an area of SW Hungary (southern Baranya County) that stretches along the northern banks of the river Dráva (Figure 1). Most of the study area is located on an Early Holocene floodplain that consists of a series of aggradational and

degradational sequences, while the eastern part encroaches on Late Pleistocene paleodunes and loess terraces. The succession of cut-off meanders and oxbow lakes makes for highly variable parent material and soil texture. The area was more directly and frequently subjected to fluvial sedimentation and erosion until nineteenth century levee construction and stream canalization (Kertész et al., 1990; Lovász, 1977). Owing to alternating sub-Mediterranean and continental air masses, most rainfall occurs in winter and late spring, with late summer as the driest period (Mean Annual Precipitation 670-700 mm). Temperatures in the Ormánság, the southernmost area of the country, are generally higher than national average (Mean Annual Temperature 11 °C). This factor alone extends the growing season of such crops as watermelon, which has increasingly become a major source of income for local smallholders (Kolyris, 1995; Lovász, 1977).

There are six major soil types in the area and several variants, for a total of 14 soil types. Based on the Soil Fertility Control System database for cash-crop farmland under cooperative management (AIIR⁴), most of the soils are well drained *Hydromorphic meadow loams* (ca. 54 percent of former cooperatives' farmland), which comprise the soils used by the households discussed below. Such a soil type is roughly equivalent to *Endoaquolls* under the USDA classification system (USDA, 1998). *Hydromorphic meadow loams* are typically moderately acidic sandy loams with low to moderate nutrient status relative to cash-cropping requirements.

With 21,280 inhabitants over 668.44 km², population density in the area is relatively low (32 persons/km²) and total population has been steadily declining since a century ago (Kolyris, 1995; Central Statistical Office, 1992; 2001). Any explanation for anthropogenic environmental change in the area must therefore exclude population pressure and concentrate on other social processes. From at least the 1980s, land use in the Ormánság is characterized by a high proportion of farmed area (56 percent) with nearly half of the local workforce engaged in agriculture, 62 percent of families operating their own farms, and 60 percent of families involved in subsistence farming (Kolyris, 1995; Baranya County Central Statistical Office, 1995; Central Statistical Office, 1992). As most inhabitants rely on both subsistence and commercial farming for their livelihood, soil constitutes a pivotal resource for the local economy. Crops consist mainly of fodder, cereals, maize, and *triticale* (a wheat-rye hybrid). Watermelon, soy, beet, and cucumber are additional widespread crops. The cropping system entails annual crop rotation and biannual fallowing, in the case of some farmers (Kolyris, 1995; Föld Hivatal, 1999).

Like much of the Hungarian countryside, the Ormánság has been negatively affected by the rapid economic downturn of the 1990s as a result of the restructuring and privatization of the agricultural sector (exemplified by the process of increasing production prices accompanied by subsidy reduction and market contraction). Official land privatization policies granted vouchers to those who owned or who have inheritance rights for land confiscated in 1948; however, in addition to compensation, land redistribution has occurred through direct citizen purchase and quasi-legal contracts with non-citizens (Kovách, 1998; Swain, 1999; Symes, 1993). These changes have affected farming communities through direct yet partial articulation with regional and world markets (e.g., contract farming, local foreign-owned enterprises), land concentration, widespread poverty (hidden by administrative unit aggregation of data), rural unemployment that is higher than national average, and a rise in subsistence farming,

inter alii. Since 1991, nine of the 15 Ormánság cooperative farms have disappeared, while the remaining six were privatized into shareholding companies, one under foreign ownership (Ormányság Foundation et al., 1995). Land privatization through compensation vouchers between 1991 and 1995 has eventuated into the multiplication of smallholders and some land ownership concentration tendencies. According to a 1995 Ormánság Development Association survey, 93 percent of farms have 50 hectares or less, which is much higher than national figures, which were about 24 and 43 percent in 1996 and 2004 respectively (Agricultural Economics Research Institute, 1997, 2005).

Methods

The results discussed below are part of a larger project carried out between 1997 and 1999, involving semi-structured interviews and time-budget questionnaires with 40 participants from 31 households from ten villages. They are from ten villages, operate small-scale cash-crop and/or subsistence farms⁵, and own on average 14.4 ha ($s = 25.2$) for cash-crops and 368.4 m² ($s = 323$) for subsistence farming⁶. Additional interviews were conducted with managers, agronomists, and other employees in large-scale farms and with local government officials. Owing to budget constraints, soils sampling was carried out for six households and two larger-scale operations⁷. Interviewees were identified and contacted through local non-governmental organizations, local government officials, and acquaintances. Participants were interviewed separately whenever possible and were asked questions pertaining to demographic characteristics, economic conditions, and management practices in subsistence and commercial plots.

Soil sampling and analysis were conducted between 16 and 25 March 1999, before sowing, fertilizer and manure application, or seedling placement at each plot. A brief interview and a sketch map accompanied each sampling episode, whereby soil remediation, fertilizer, chemical application, machinery use, and cropping histories were included. Soil type, slope percentage, and drainage conditions were derived from field inspection and deduced from agronomic and topographical maps (Országos Földügyi és Térképészeti Hivatal, 1968a, 1968b; MÉM Országos Földügyi és Térképészeti Hivatal, 1983). Samples were processed and analyzed by the internationally accredited Laboratory of the Soil Conservation and Crop Protection Station of Fejér Megye (FMNTÁ) in Velence, Central Hungary.

Interviewees (male respondents except one) provided information on the spatial extent of each plot. When available, they furnished copies of an ownership certificate from the Land Registration Office, wherein location and measurements are all indicated cartographically. Additional plot-specific historical data pertaining to fertilizer application, liming episodes, and soil analytical results were gathered from the soil analysis archives and AIIR database at the Soil Conservation and Crop Protection Station of Baranya County (BMNTÁ), the TIM soil monitoring database at the FNTÁ (see Várallyai, 1995), and the archived documents from the farming co-operative that formerly managed most of the land sampled in this project.

Additional plot-specific historical data were gathered from archived soil-testing results in the AIIR database at the Soil Conservation and Crop Protection Station of Baranya County (BMNTÁ, 1991), from the TIM soil monitoring database at the FNTÁ (1997), and from documentation at the farming cooperative that formerly managed most of the land sampled in this project. In this manner, lab analysis results could be

compared, whenever possible, to data from the pre-1991 cooperative farm management period. However, historical analysis was not feasible for parcels, including subsistence parcels, that were never under cooperative farm management (thus only eight of the 25 samples can be used to analyze continuities from cooperative ownership to private use).

A two-sheared, open soil corer was used to collect samples at single-tiered depth (5-20 cm). This standard systematic sampling procedure involves at least one composite sample per hectare, consisting of a thoroughly mixed set of samples taken at regular intervals along two diagonals from the corner of a one-hectare area. Therefore, the term “samples” herein actually refers to composite samples for each plot examined. Sampling intervals were suited to the geometric shape of each subplot area. Locations near gravel roads or any other such contaminating source were avoided by a distance of at least 30 m (Brown, 1987; Tisdale et al., 1993; Troeh and Thompson, 1993; Webster and Oliver, 1990). Since funds were insufficient for sampling at higher spatial resolution, parcel sections with unrepresentative characteristics (e.g., temporarily waterlogged) were skipped.

Soil quality indicators were used in addition to local soil type data to determine the degree of impact of local farming practices on soil conditions in general. Since the 1980s, scientific concern with soil quality has grown in conjunction with greater emphasis on sustainability (Karen et al., 2001). To this end, biological, physical, and chemical indicators have been devised to enable overall assessments of soil quality, and some of these indicators are the basis for the interpretations of soil conditions presented below (Table 1)⁸. Soil quality indicators are comprised of ranges, with minimum and maximum values that have to be interpreted according to potentials that differ according to soil type and the needs of flora (e.g., crops) and fauna (e.g., humans) sustained by a soil. Knowing what conditions are optimal for soil functioning enables the evaluation of human impact.

Gender relations, farming resources, and anthropogenic soil quality change in the Ormánság

Gender relations in the area are characterised by a patriarchal gender division of labour with male-dominated land ownership⁹ and commercial farming and female-dominated housework and subsistence farming. Results from the semi-structured interviews of farming family members showed 78% of women’s work-time is unpaid and in the home and subsistence plot, compared to 31% for men. The gendered distribution of unpaid work-time is approximately even on subsistence plots, so that the bulk of women’s work-time is in housework. On commercial plots, however, men contribute most of the work-time as part of self-employment activity. Women process subsistence crops, prepare meals, carry out the book-keeping, and often sell produce on roadsides, whereas men are primary users of machinery and agricultural inputs, such as chemical fertilisers and manure, and tend to be labour managers on commercial plots. A minority of interviewed women have found paid work in service sector activities, including municipalities and farming cooperatives (Anonymous, 2003: 511-512, 2006).

This division of tasks mirrors somewhat the tendencies noticeable nationally, featuring the progressive migration of women to tertiary sector employment, which has brought relative economic advantage for many women since the early 1990s. In contrast, women working in economic sectors such as manufacturing and processing have been

disproportionately affected by layoffs compared to men (Corrin, 1994; Fodor 2002; ILO, 1998: 12-13, 99-104; see also Szent-Györgyi, 1993), especially in rural areas like the Ormánság.

Such patriarchal arrangements have developed through state and market institutions that have shaped the control of and access to farming resources and technologies and the agricultural division of labour at the local level. Since the late 1960s, in conjunction with export-orientation and farm mechanisation, the state-socialist government excluded women from access or use of farming technologies and inputs through worker protection laws (Asztalos Morell 1999; see also Lengyel, 1982; Sas, 1988). This contributed to a decrease in women's paid work in the cropping and husbandry systems of large-scale commercial farms and to the monopolisation of farming technologies and inputs that can be currently witnessed. Whereas the gender division of labour has shifted over time through a slight increase in male involvement in unpaid housework, it remains structurally patriarchal. Rural women still do most of the housework and grow subsistence crops and perform most such work manually. In contrast, men control agrochemicals and manure inputs, monopolise farming machinery, and perform appliance and machinery repairs in the home. Importantly, most large-scale farm business managers and technicians, who make cropping and soil treatment decisions, continue to be men (Asztalos Morell, 2005; Maltby, 1994; Répássy 1991; van der Graaf 1996).

These larger-scale historical trends are reflected by and large in the Ormánság as well. From interview results, a gendered discrepancy is evident in employment patterns, with 32% of interviewed women unemployed, in contrast to 14% for men. Labour-saving farming technologies are monopolised by men and nearly all large-scale farm managers and technicians are men, despite women's high level of agronomic training, so that women's work continues to be predominantly manual and subordinated. Despite legal prohibitions, however, both men and women apply biocides, though the latter only on subsistence plots. So, even though women's commercial agriculture employment has decreased more than men's (this is also at the national level), women continue to be involved in farming, especially in retail and subsistence plot management (Anonymous, 2000).

These developments contribute to the differentiation of soil impacts according to gender. Gender-differentiated local knowledge and associated environmental practices within family farms and other social institutions can have relatively direct consequences on how soils are used. In this case, a local patriarchal system results in largely higher quality soils in women-managed plots (Anonymous, 2002). Male-controlled commercial plots are associated with soils of greater acidity and hence lower fertility and female-controlled subsistence plots were characterised by excessive amounts of phosphates¹⁰.

The connections between gender relations and farm parcel soil characteristics are exposed below by considering internal gendered family farm dynamics linked to farming resource access (e.g., agrochemicals) and land use, as well as soil and parcel characteristics and historical (state-socialist) and current land-use effects on soil quality. These processes are analysed so as to provide an understanding of how gender relations in farming households result in gender-specific soil management practices that modify and, since people-environment relations are mutually constitutive, are modified by soil

quality. Following a brief introduction, the commercial and subsistence plots' soil conditions and the farm's cropping system (crop types and yield, fertilizer management) are described for the farming household. Gender relations are then discussed in relation to the division of labour, farming resource access, land use practices, and gender-specific impacts.

Household A

The A's began working in agriculture 11 years ago, but Ms. A is now employed as a book-keeper at the mayor's office. Mr. A runs the family's six ha commercial plot, which he owns through inheritance. The A's share ownership of the house and the backyard subsistence plots.

The A's commercial plot was part of a 35 ha local cooperative parcel and lies a few km outside village limits. The parcel was limed in 1985 as part of a general effort to combat acidification and falling maize yields. As shown on Table 3, the raising of pH from 5.75 to 6.50 and of CaCO_3 from 0 to 0.1% is noticeable through 1990, when the parcel was still under cooperative farm management. Fertilizer additions were nutrient-specific and calibrated through the analysis of soil sampling results every three years. During the last year of cooperative management, 188, 102, and 147 kg/ha of N, P, and K fertilizer were respectively added. Maize yields nevertheless fell as a consequence of actual fertility decrease, which is masked by the pH-raising effects of liming (Table 2).

Following privatization, 2500 kg/ha of horse manure were applied to the six ha plot in 1991 and 3200 kg/ha in 1997, mostly on the plot section that slopes towards the canal. Synthetic N fertilizer was also added twice (150 kg/ha in 1996 and 200 kg/ha in 1997) and an NPK mixture once (700 kg/ha in 1997). As a result, maize yield jumped from 6 to 10 t/ha between 1996 and 1997, but fell to 4 t/ha the following year in 1998, when no fertilizer was added (the national average was 6 t/ha, according to FAOSTAT, <http://faostat.fao.org>). Growing maize, a nutrient-demanding crop, has proven difficult without soil amendments. In contrast, triticale yield, a more acidity-resistant crop, has fared better¹¹, even compared to the national average (2.8 t/ha, as reported in FAOSTAT).

The lack of sustained fertilizer application is connected to lower pH levels in the commercial plot. This can also explain falls in CaCO_3 and Mg levels¹² as well as the much lower N content¹³. In contrast, P and K levels have risen markedly. This can be explained by excessive and sporadic fertilizer additions due to highly variable disposable income. This land use practice is leading to general fertility decline, as in the case of the cooperative's management practices. But in the case of the cooperative the problem has been a lack of OM renewal through time (no manure application), whereas in the case of the A's the same problem is compounded by poor fertilizer management and excessive manure amendment¹⁴.

The subsistence plot displays higher overall soil quality, in terms of pH, CaCO_3 , and OM values, in general conformity with both soil type and soil quality indicators. This results from application of organic household wastes, manure, and surplus NPK fertilizer mixture. Though nutrient levels are higher, they remain low for N (relative to intrinsic soil properties, but not in terms of general soil quality) and excessive for K and P. P accumulation may also be due to decreasing P availability to plants with waterlogged conditions (typical in this area, especially near canals and creeks), as P becomes tied up with the chemically reduced form of iron (Adams, 1980: 663). High P and K levels imply

the potential for the nutrient enrichment of the nearby canal, leading to eutrophication, when soil is eroded down slope.

The divergence in the soil quality of commercial and subsistence plots can be traced to the prevailing gender division of labor within the household. Ms. A's housework responsibilities, especially meal preparation, farming business paperwork, crop processing, household waste management, animal feeding, and cow milking, limit Ms. A's involvement in the farming process. Ms. A is also busied by the selling of piglets, calves, and milk to local merchants, who resell them to large-scale firms. Ms. A's expertise in book-keeping and paperwork, as well as her responsibilities for animal husbandry, has served to legitimize her prevalent involvement in such market activity.

However, she defers to her husband on technical matters of cash-crop production, in spite of her informal agronomic training, since he has the technical training in machinery repair and access to agricultural machinery and agronomic consultations at the local (now privatized) cooperative. His contacts also help him to rent labor and machinery at favorable rates, thereby expediting harvesting and gathering. The manner in which the A's categorize crops reinforces Mr. A's control over cash-cropping. Both spouses refer to subsistence crops as *apróvetemények* ("tiny vegetables", literally) of marginal economic importance, regardless of their fundamental contribution to every meal the family consumes. This situation legitimizes Mr. A's monopoly over industrialized aspects of land use and commercial cropping systems. Consequently, though Ms. A and her mother do most of the animal husbandry and decisions over commercial cropping systems and animal husbandry are done jointly, Mr. A controls the disposal of manure, fertilizer and biocide¹⁵ management, produce sales, feed purchases, animal slaughter, and buyer contact.

The division of labor and gender-based resource access affect the cropping and input systems in the different plots. In the commercial plot, Mr. A, using machinery and paid workers, prepares the land for cultivation, sows, applies manure and agrochemicals, and harvests and sells the crops. The cropping system is nutrient-demanding and soils are negatively affected by fertilizer management and possibly biocide application and machinery use. The latter two often lead, through temporary organism population reductions and decreased aeration through compaction, to reduced biological activity, which helps break down and cycle nutrients and incorporate OM into the soil. The general results of Mr. A's land use practices on the commercial parcels have been declining crop yields and the eutrophication of the adjacent canal through P enrichment. Mr. A remarked that the plants living along the canal benefit from the nutrients being washed from his field. When asked about the reason for continuing to spread so much fertilizer, he replied that he must ensure a decent harvest for the family.

In the subsistence plots, Mr. A manures and applies synthetic fertilizers. The rest, sowing, transplanting, and weeding, is mostly done by Ms. A and her mother without machinery. Harvest is done collectively and manually. The cropping system is bio-diverse, consisting of relatively low-nutrient demanding crops, selected by Ms. A and her mother (e.g., beans, celeriac, and paprika). However, Mr. A's agrochemical and manure inputs are beyond crop demand, so that soil quality is negatively affected in terms of excessive nutrient content, excepting nitrate (for such vegetable crops and their nutritional requirements, see Barber, 1995; Fageria et al., 1997). The nutrient level

excesses can be partially explained by the transfer of surplus from an NPK fertilizer mixture that was applied to the farm plot in 1997 and the over-application of P_2O_5 -rich manure. Other soil quality indicators are positive thanks in part to Ms. A and her mother's soil management practices, which are related to differential resource access (e.g., access to Mg- and Ca-rich chicken waste and lack of access to biocide and machinery).

Household B

In their late forties, the B's have a diverse employment background. Ms. B works full-time at the local kindergarten. Until becoming a farmer after 1989, Mr. B worked for the cooperative as a machine operator and repairs person. He also works for the local organic farm run by a local foundation. The B's possess about 13 ha of land under different titles and disposal arrangements. Ms. B owns 1.9 ha through compensation vouchers, while five ha under the son's title are rented out¹⁶. The remaining six ha inherited by Mr. B are used commercially. The spouses jointly own the house, backyard subsistence plot, and machinery, including a tractor. In contrast to family A, the B's income is lower, Mr. B has the higher income, and some of the commercial plots are under Ms. B.

Ms. B's 1.9 ha plot borders the subsistence parcel behind the house. It is part of a former cooperative farm's seven ha that lay fallow between 1989 and 1991 (synthetic fertilizer was still applied) and formed part of a 16 ha plot (Table 3). The pH, $CaCO_3$ (compared to the last recorded value of 2% in 1987), and OM declined moderately, but the latter two were just within acceptable levels for sustainability and well below expected values for the local soil type. Nutrient levels were excessive, except in the cases of K and Mg, which were low but within range for acceptable soil quality. This soil status resulted from fertilizer and lime management that featured the increase of N and P fertilizer respectively from 159 and 104 to 204 and 245 kg/ha between 1986 and 1990. K fertilizer additions were reduced from 200 to 160 kg/ha between 1986 and 1988, but were raised again to 206 kg/ha by 1990 (accurate liming data are missing).

Following privatization, the soil quality of the 1.9 ha portion of the parcel has become comparatively degraded. Values for pH, $CaCO_3$, and Mg are below both sustainability and local soil type range. The accelerated decline in pH may be due to sandier texture than typical, which reduces the intrinsic capacity of soils to buffer against acidity and retain bases (e.g., Ca, which raises pH). There have been further reductions in OM and N, the latter of which was already problematic, but in terms of excess, rather than dearth. K levels have improved, but P has increased well beyond maximum. In contrast, the soil quality on the adjacent subsistence plot tends to be higher with all indicators except K, which is still within desirable range. The problem of high P content remains, however, and is even accentuated. These results are partially due to inappropriate manure and synthetic fertilizer additions, which have been sporadic and exaggerated, as in the case of family A. The problem is compounded by the low soil quality that the B's inherited from the cooperative farm (under male management) as well as intrinsic soil properties and spatial heterogeneity. Interestingly, soil quality decline is proceeding in the absence of biocides, which the B's, citing potential health impacts, prefer to avoid using near the house.

Mr. B's six ha were part of a 42 ha parcel under cooperative farm management (the area under cultivation sometimes shrank due to fallow periods or temporary conversion to pasture). The land is located in a wooded and swampy area some two km from the house. It is difficult to reach, being served only by a clayey beaten path at some distance from a main road. Though most historical soil testing data seem to have been lost, some deductions can be made (Table 4). There was appreciable improvement of pH over time, a long-term effect of liming in 1986 and 1987 (4500 and 4600 kg/ha respectively). Levels of pH are slightly above the minimum acceptable for sustainability, but well below expected for the local soil type. One of the parcels has much higher pH, which could be due to localized excess liming and the spatial heterogeneity of the soil type, which can be masked by sampling procedure. Yet overall soil status was impoverished, given decreasing OM and nutrient levels and the meager 1991 maize yields. The fall was attenuated by increasing fertilizer additions from 1988 (147, 125, and 76 kg/ha of N, P, and K respectively) to 1990 (204, 244, and 276 kg/ha of N, P, and K respectively). Nevertheless, N and P levels already exceeded sustainability ranges. The worsening soil quality that the B's inherited from the cooperative farm was therefore masked by soil amendments that the B family either cannot afford or do not have the training to carry out effectively (in addition to relying on rain-fed irrigation, due to lack of canal or well access). So, pH values remain high due to past liming, but CaCO_3 is unsustainably poor, and OM, N, and Mg are low (too low even compared to local soil type average). P values have increased beyond acceptable levels, due to inappropriate manuring and synthetic fertilizer additions, as in the family A case. K levels are the only ones that are optimal or well within sustainability range.

As in the case of the A household, the above differences in the plots' soil quality is at least partially linked to gender-specific environmental practices derived from intra-household gender relations. Ms. B performs nearly all housework alone, including canning and processing subsistence crops, chicken raising, meal preparation, and book-keeping. Despite her informal experience, Ms. B feels that her farming knowledge is of lesser importance, and, though interested, she has too little time for market transactions. Existing divisions of work therefore constrain Ms. B's involvement in farming even more than in the case of Ms. A. Mr. B and son conduct household repairs, tend to the pigs, and monopolize farming machinery and agrochemicals, as well as the sale of produce and meat. This is owing to Mr. B's and his son's contacts, formal education, and the additional income derived from their tractor operation services on other farms.

Consequently, in commercial plots, all cropping system decisions and machine-aided activities are done by Mr. B and the son, even on the jointly owned parcel. Mr. B has converted the tractor into a multi-purpose farming vehicle so as to reduce soil compaction. Mr. B and the son obtain horse manure from the local organic farm and use their own pig manure. They spread both types of manure on both commercial cropping areas. They apply synthetic fertilizers and biocides as well, when they can afford to buy them. In Ms. B's 1.9 ha plot, however, the entire family is involved in harvesting and gathering manually and less to no agrochemical inputs are applied, despite the low pH problem (which reduces crop nutrient uptake). This parsimonious treatment implies less importance given to Ms. B's land. Regardless, Mr. B decided to produce maize on this plot thenceforth.

The subsistence plot is irrigated through a well, which is also used to feed and clean pigs and chickens. Cropping system decisions are made through family discussion, but Ms. B has prerogative over crop type (the crops grown are virtually the same as those in farm A's subsistence plot). Ms. B hoes and weeds manually, though sowing is shared. Mr. B and son apply fertilizer and prepare land and harvest with the tractor. Compared to farm A, however, men contribute more labor-time to the subsistence plot. Men's monopoly over agrochemicals input, as in the case of household A, means that a mismatch exists between crop requirement and fertilizer amendment, which Mr. B exaggerates as a consequence of his treatment of vegetables as nutrient-demanding cereal crops, resulting particularly in excess P in both subsistence and commercial plots.

Household C

The C family is comprised of two recent pensioners who have been informally involved in agriculture most of their lives. Ms. C, now in her fifties, has partially retired, employed part-time as a social worker. Mr. C is in his early sixties and has retired. Their untaxed revenues from informally selling cash-crops supplement their very low pensions.

In 1995, the C's became the joint owners of seven ha through compensation vouchers, part of Ms. C's inheritance from her grandfather. They rent out two ha because of the distance and produce on five ha behind the house. The latter area is circumscribed by woods to the north, a canal to the east, a vehicle-wide dirt path to the west, and residences to the south. The canal is the same one that the A's use for irrigating their crops. The plot was part of a 38 ha apricot orchard, sprayed yearly with fungicide, until it was appropriated by the local cooperative in 1965. The field was then cropped with silage maize for a decade until wheat began to be cultivated. Eventually, the cropping system was reverted to maize and by 1989 the parcel was enlarged by three ha.

Cooperative farm fertilizer management featured, between 1986 and 1987, an initial decrease of N fertilizer from 105 to 99 kg/ha, while P and K additions increased from 107 and 135 to 117 and 245 kg/ha. Subsequently, synthetic N additions increased to levels between 266 and 298 kg/ha and K additions oscillated between 173 and 176 kg/ha, but were augmented to 241 kg/ha by 1990. P fertilizer additions were reduced to 92 kg/ha in 1988 and then gradually increased to 166 kg/ha in 1990.

Problems with pH, well below sustainability range, began to be noticed in the mid 1980s (Table 4) and the field was limed in 1987 with 1800 kg/ha. Interestingly, CaCO_3 content did not rise as in family A's commercial plot, possibly due to intrinsic soil properties¹⁷. OM was also in decline until liming occurred, but it did not recover to 1982 levels. N levels apparently remained stable and within acceptable soil quality range, but there are insufficient data available to determine soil N status after 1985. P content became excessive until fertilizer P additions were decreased in 1988 and stayed within acceptable soil quality range, though below local soil levels. K and Mg content steadily increased over time to reach, by 1988, near expected levels for local soil conditions; however, K levels began exceeding acceptable range in terms of general soil quality indicators.

The C's intensive watermelon cultivation and fertilizer management practices are associated with further reductions in OM and Mg, substantial increases in P and K, and a relatively improved pH. The last variable is partially a beneficial outcome, as in the case of household B, of more recent lime additions through the former cooperative farm. N

levels are on the low range for soil quality indicators, but very low compared to local soil properties. OM and Mg figures are especially low in comparison to local soil characteristics, but the P and K levels have reached pollution potential due to a sharp increase in synthetic P and K fertilizer application to 400 kg/ha, nearly double the quantity applied by the cooperative farm in the late 1980s. The 50 m² subsistence plot is contiguous with the rest of the cultivated land and is usually cropped with garlic, onions, tomatoes, paprika, cabbage, and lettuce. As in the case of the A family, the subsistence plot is characterized by relatively high pH, adequate OM, and greater fertility compared to the adjacent commercial plots, despite negligible amounts of CaCO₃ (Table 5). Values for pH and some nutrients in both types of plots have probably been raised as a result of the five/six-year fallow period prior to ownership change, besides the C's environmental practices.

There are, however, noticeably high concentrations of P₂O₅ and K₂O, which are related to manure applications over a small area and to higher rates of synthetic fertilizer additions compared to the state-socialist management period. Mr. C has applied 200, 400, and 400 kg/ha of fertilizer N, P, and K respectively in 1996 and 1998. As in the case of the A's' subsistence plot, the fertilizer management monopolized by the males in the family has eventuated in excessive nutrient content that contributes to eutrophication problems in the adjacent canal.

The higher values for the pedochemical indicators on the subsistence plot are, again, traceable to gender-specific environmental practices due to gendered processes within the household. Ms. C contributes all housework (mostly sowing, cleaning, and washing, feeding pigs and chickens; household repairs are done through paid services). In contrast to the previously discussed households, she is slightly less constrained by housework (e.g., meal preparation and crop processing is minimized by purchases of prepared foods) and the work of raising and selling crops, pigs, and chickens is mostly shared. Ms. C consequently has a direct say in all matters pertaining to farm production. This is partly due to the fact that neither spouse can claim exclusive knowledge regarding agriculture as they both received informal training. As Ms. C put it, the decision-making is shared *kenyérről boltba* (from bread to shop). With the help of relatives and their daughter and son, the C's work is lessened and their finances are more stable.

The C's refer to their subsistence crops as *vetemények* (vegetables), without diminutives, in striking contrast to the naming practice in the A family. The subsistence plot, however, is not as important as it is to other families in the area. Thus it is not surprising that to Ms. C, the subsistence plot is of lesser significance than the fruit trees in her backyard. Despite its relatively low importance, the subsistence plot does provide Ms. C bartering possibilities with neighbors, especially when she prepares meals herself. Fruits such as apples, apricots, pear, and sour cherry provide gifts for friends and relatives as well as a means to produce *pálinka* (a very strong alcoholic beverage).

Though sharing work on subsistence and commercial plots, the C's division of tasks resembles those described above. This results in Ms. C typically devoting more hours. Ms. C prepares the soil and weeds and hoes manually and handles book-keeping and watermelon sales exclusively. Mr. C sows and digs with the aid of a tractor (as does the son), purchases seed and fertilizer, irrigates the crops (through an adjacent canal), and applies fertilizer. As Ms. B, Ms. C prefers to avoid biocides altogether. She fears being

poisoned, citing examples of local farmers who have been hospitalized or have died as a consequence of biocide application¹⁸. This differs from family A's continued use of biocides, which coincides with Ms. A's marginal role in farming decisions. However, Ms. C's greater involvement in commercial farming has eventuated in total abstinence from biocides on all plots, unlike in the case of household B, where Ms. B's lesser involvement in commercial farming coincides with biocide applications on commercial plots. Overall, gender relations in household C result in females contributing the least soil-impacting activities. Males are engaged in more soil-altering impacts such as possibly mild compaction through machinery use, as in the above cases, but, more importantly for this case study, the excessive use of fertilizer. In this instance, as a result of financial stability, more fertilizer is purchased and added more consistently, lowering pedochemical soil quality in both commercial and subsistence plots to a greater degree than the other households.

Gender relations, abandonment of cultivation, and soil quality implications

The effects of gender relations on soil quality are not only manifested through subsistence or commercial activities, but also through their suspension. In two cases from the villages of Sellye and Vajszló, women abandoned work on their subsistence plots because of non-farming employment and/or the ability to afford buying more food. In both cases, the husbands did not take control of subsistence farming operations, even though they would have had more time available to do so; instead, the plots were eventually left uncultivated. In the case of the Vajszló household, the husband turned the subsistence parcel into a commercial plot for cucumber production, when his spouse was able to obtain sufficient funds to run a clothing shop full time. Demonstrating the continuing linkage between masculinity and agricultural productivism, he abandoned the venture when it became unprofitable and the former subsistence plot is now overgrown with weeds. In the case of the Sellye household, the husband was sacked when the local metal works plant closed in 1991 and the wife sought and found employment in a local textile factory¹⁹, where she endures sweatshop conditions (e.g., ten-hour days with few, short breaks, poor ventilation). This situation prevents her from continuing to tend the subsistence plot, yet the husband's unwillingness to learn how to run the subsistence plot resulted in the abandonment of cultivation.

These patriarchal relations, similar to those noted above, can lead to potentially more positive anthropogenic effects by decreasing the extraction of soil nutrients through farming. Soils that were used to grow high nutrient-demanding crops will be left fallow and potentially regenerate fertility levels, or soils used for subsistence plots will receive less P and K fertilizer, thereby reducing potentially polluting runoff into lakes and streams. It is unfortunate that more soil data on these plots could not be gathered (budget constraints prevented further soil sampling). Nevertheless, such inadvertent fallowing complicates the soil geography outcomes of social relations; similar gender relations are not related to soil quality in a linear fashion, but are contingent on a conjuncture of social and biophysical processes.

Mutually constitutive aspects of soil and gendered household processes

The above-described impacts on soil quality through past and current gender-specific environmental practices form part of an ongoing dialectical relationship between local inhabitants and soils that result in changes or reinforcements to both internal

household dynamics and soil quality (in connection to social processes at multiple scales that cannot be discussed here). In this section, I wish to explore another, more dynamic aspect of spatial patterning of soil characteristics by highlighting the mutual determination of people-environment relations, which, if more data were available, could be developed into a sort of dynamic model based on iterative functions that could enable a fuller exploration soil quality shifts over space and time.

As the A's contribute to modifying the soils they farm through gender-specific impacts, the changing soil conditions affect their farming activities, whether for subsistence or commercial purposes. One example of the mutual determination of internal family farm processes and wider ecological dynamics is through the combined effects of soil quality change and eutrophication in the canal abutting both the sloping commercial parcel and backyard subsistence plot. Through nutrient runoff from Mr. A's fertilizer additions on both commercial and subsistence plots (and those of other male farmers), soils adjacent to the canal are increasingly waterlogged during the growing season (more sediment is being trapped in the canal, raising water levels). The higher water levels are also partially a result of sudden snowmelts during the early spring, which have been increasing in the past few years. At the same time, soil quality has declined in the commercial plots and has remained largely positive in the subsistence plot. These changes in soil conditions have affected the A's cropping system and land use. On the commercial plots, Mr. A plans to grow watermelon on flatter sections and continue growing maize on the higher-elevated sloping part, where he has had occasional success. However, the waterlogging problem has forced the A's in 1999 to abandon their backyard subsistence plot adjacent to the canal (not sampled in this study) because of hampered manuring and plant growth. They have jointly decided instead to grow more subsistence crops on a 0.5 ha plot further away (also not sampled) and recently purchased under shared title, where land is prepared with the aid of machinery. Additionally, the desire to secure more revenue has convinced the A's that some of that newer plot be devoted to a cash-crop that they can find useful for subsistence as well, in case it is not worth selling. The plot will continue to be used to grow fodder crops for the pigs they raise²⁰, but the fear of inadequate harvests manifests itself increasingly through the expansion of cash-crop area and further subordinates subsistence to market-oriented production. Meanwhile, the main subsistence plot has so far remained a reliable source of food precisely through the lack of farming resource access affecting Ms. A and her mother's land use practices. Soil quality, especially in the plots adjacent to the house, has deteriorated since ownership change. Intrinsic soil properties limit what can be grown and to what amount and there are obvious spatial heterogeneities (e.g., topographical) within the same soil type that impose more limits on the plots adjacent to the house. The general tendencies in soil quality, however, are due to an additional combination of degradation and improvements through former (male controlled) cooperative farm management and recent inadequacies in cropping system that are gender-specific. Intensive and continuous nutrient removal through crop-demanding crops, such as maize, only exacerbates matters.

Mr. B's six ha plot, though faring better than the other parcel of land, is tending toward decreasing soil quality, even if it has benefited from past successes in liming amendment. On Ms. B's 1.9 ha plot, the tendency towards soil quality decline is accentuated by male monopoly of inputs, which coincides with less fertilizer or no liming

amendment. The ensuing relatively greater productivity and soil quality on Mr. B's plot reinforces the importance of land under his name and his economic standing within the family. If Ms. B's land quality worsens, the plot may have to be abandoned and converted to another form of land use. Given prevailing gender relations, it is unlikely that the parcel will be turned toward subsistence and may instead become a forage cropping area for the expansion of male-controlled pig husbandry. In the subsistence plot, Ms. B's lack of access to agrochemicals has led to higher soil quality relative to the adjacent commercial parcel (and, for some indicators, even compared to the six ha plot). In contrast to farm A, the reduction in soil quality on the subsistence plot is much more severe and, since internal family arrangements are preventing any land conversion for subsistence production, this is curtailing Ms. B's ability to provide food for the kitchen. The situation is forcing her to rely more on her wages and on informal exchanges with neighbors to obtain vegetables, such as cabbage, cauliflower, and tomatoes, which they now have difficulty growing. This process has implications for her gendered status in that, as soil quality further deteriorates, her wages and bartering skills may become eventually more important than her manual work in the plot and the kitchen (unless there is a shift in men's role toward subsistence production).

In the C's' case, soil quality deterioration has yet to be experienced in terms of yield declines in either subsistence or commercial plots. With 28 and 30 t/ha of watermelon produced in 1996 and 1998 respectively, yields have been below the C's expectations (40-50 t/ha is the potential yield); however, they were above the national average of about 15-17 t/ha (calculated from online FAOSTAT data for 1996-1998). The C's express concern about P and K levels, even though watermelon is not particularly demanding for such nutrients, especially relative to cereal crops. The C's' preoccupation with these nutrient deficiencies has led them to believe that increasing the rate of synthetic fertilizers will improve soil conditions. The effect, however, has been an overabundance of soil P and K with no appreciable productivity expansion. It appears that there are Mg and Ca deficiencies in some parts of the plot, rather than a low P or K problem, and these may affect future yields. Additionally, the synthetic fertilizer is not reaching the crop, possibly owing to erroneous fertilizer placement and timing and/or the preferential pH-dependent binding of the nutrients with other chemical elements or soil particle surfaces. Further study of this site and more information about fertilizer management would improve interpretation of soil analysis results. Nevertheless, it can be said that the surplus P is probably feeding the burgeoning algae and vegetation communities in the irrigation canal, as in the case of the other households. While contributing to larger-scale environmental problems, as other households, the C's relative success in growing watermelon helps cement established gender roles and gendered environmental practices, which will continue to impact soil petrochemical processes in similar ways.

Discussion

The experiences of the households described above suggest that gender relations are crucial to consider in that they give rise to uneven access to and control over farming resources (landed property, agrochemicals, machinery, manure, etc.) and shape the decisions regarding cropping system and production aims and priorities. In spite of women farmers at times converging with men farmers through training, technical

expertise, and farming experience, the impacts on soil properties are still largely gender-specific, thanks in part to outcomes in the preceding political system. This is because, as encountered in other social contexts, the gender division of labor and resource access and control within households has not been substantively altered, such as the greater importance associated with men's incomes irrespective of amount and the uneven division of housework time (Fodor, 2004; Haugen and Brandth, 1994; Sachs, 1996).

This bears direct ecological consequences, as exemplified in the variability of soil quality according to gender-based control. The soil quality of women-controlled subsistence plots exceeds that of usually men-controlled cash-crop fields, but gender-differentiated labor tasks and control over farm resources results in excessive fertilizer applications by men on subsistence plots, leading to aspects of soil quality decline. The latter phenomenon applies equally to family farm C, though, as demonstrated elsewhere, such household arrangements are exceptional and age-related (Anonymous, 2000). The symbolic and material subordination of subsistence crops to commercial prerogatives, through, for instance, calling the former small or kitchen vegetables and expanding cash-cropping in family farm operations, reinforces and legitimizes male superiority in the family farm, since men monopolize commercial plot management or otherwise the farming technologies and inputs (the latter even in family farm C).

Human environmental impact is clearly gender-differentiated through household relations, at least in this and similar contexts, but it also affects, in turn, the farming possibilities that households face. Previous male-dominated management under the cooperative system, for instance, can result in soil fertility declines that limit potential crop growth for family farms that acquired, through diverse means, previously cooperative-owned land. Decisions made within family farms remain largely male-dominated in the area, but often must contend with reduced access to agrochemical inputs as a result of shifts to lower class position within society in general and the decisions made are tinged by masculinist ideals of providing for the family (Anonymous, 2002). Such decisions reinforce the tendency for high-input productivist agriculture that, in the context of diminishing availability of agrochemicals, including lime, can end up impacting soil quality even more negatively than under the cooperative system. But there are exceptions, such as family farm C, where greater age-specific egalitarianism in decision-making processes does not necessarily translate into improved soil quality, owing to gender-based divisions of tasks that involve more productivism-oriented men applying agrochemical inputs.

Soil quality on commercial plots is diminished through nutrient depletion, occasional erosion, and other negative effects, while the artificial maintenance of soil fertility can no longer be afforded through liming and other soil amendments, as used to be under cooperative farm management in the 1980s. To add to these lurking problems, family farms have inherited commercial plots sometimes degraded through past male-dominated large-scale farming operations. As a result, harvests and incomes derived from them are potentially threatened for the long-term (and so will animal husbandry, as self-provisioned fodder production is compromised), irrespective of existing economic problems that are unrelated to soil quality *per se*. Ironically, the combined effects of soil quality deterioration and economic hardships related to a wider androcentric economic system may undermine the very structures of local patriarchal family farms by reducing

the economic importance of male-dominated commercial family farming, in favor of larger-scale male-dominated operations with largely male workers and managers and a few women mostly involved in secretarial office work.

Such gender and possibly age differences in approach to farming are too variable to lend support for any claims about a direct correspondence between gender and environmental practice. For instance, both Ms. and Mr. A complain of poor water quality in the area, because of which they mainly use well water for irrigation and feed. Yet they do not connect poor water quality to harmful inputs from their own and others' farms. The same division of labor that allows a husband to claim legitimacy as principal provider also fosters an emphasis on productivity. It is through the latter that the legitimacy of the division of labor and knowledge is reinforced and that environmentally polluting soil uses are encouraged. If Ms. A were to have the same status as Mr. A, however, there may not be any difference in overall environmental practice, and this is witnessed, partially, in the case of the C household. As many women embrace industrial farming methods, women cannot be said to have a propensity for organic methods of food production. In other words, it is the reinforcement of a certain position of higher status through particular environmental practices (e.g., high-input farming) that promotes this gender differentiation within households. Differential access to technologies and inputs combine with land use practices to promote gender-specific impacts on soil characteristics. Masculinized land use and patriarchal divisions of farm work have wider ecological effects that in turn affect the prospects of family farms themselves and therefore warrant greater analytical attention in soil geography to improve our understanding of human-affected pedodiversity. These findings should temper any claims that patriarchal relations entail negative consequences with respect to soil quality.

The examples of plot cultivation abandonment underline the gendered character of subsistence farming, but also caution against any direct relationship between gendered processes and anthropogenic soil quality change. The fuller context of gender relations must be considered. In these two cases, patriarchal arrangements within the household are also the result of larger-scale political economic processes. These contingent changes to soil management, however, do not negate the importance of considering gender relations in explaining the spatial variability of soil characteristics.

Gender relations among farming households give rise to gendered patterns of soil use. The processes that maintain the agricultural gender division of labor are as diverse as the different aspects involved in farming. Inheritance and compensation for confiscated lands cement the association of profitable, official farming with the attainment and reinforcement of masculinity. Clearly, from the above analysis of farming households, women's land ownership does not guarantee control over land. The actual use to which a land will be subjected is decided by men as a result of educational, scientific, and governmental farming institutions that exclude women from mainstream agriculture and that reinforce androcentric social networks. This state of affairs is internalized in women's very practices and decision-making involvement. Ms. B, for instance, in spite of her skills in producing subsistence crops, excludes herself from making decisions regarding cash-crop production. Land cultivation practices, machinery applications, and related soil additions fall under the control of men, while women provide auxiliary and marginal labor. Soil use on cash-crop plots primarily acquires a characteristic associated

with male production tasks. The gender division of labor extends beyond the demarcation between commercial and subsistence production. Men have been increasingly involved in subsistence plots since the 1970s through state incentives for privatized production (Corrin, 1994; Répáßy, 1991; Swain, 1985). Male involvement, though, entailed the transference of existing gendered task assignments. Thus, men monopolize machinery and chemical additions, while women provide the manual labor. This reflects the division of labor on cash-cropping systems with the principal departure consisting in women making primary managerial decisions, which relate to their responsibilities as houseworkers.

Irrespective of gendered income differentials, work distribution structure, and property relations, it is women who perform housework with the exception of construction and machine repairs. Subsistence is mainly a woman's role. When a married woman finds employment or is involved in a business venture of her own, it is her mother or mother-in-law who becomes the subsistence plot manager. Men contribute typically in terms of machinery use and the application of chemicals. In animal husbandry, chickens and other fowl are within the domain of women's work. Such domesticates provide a reliable source of food that evades market vagaries, just as subsistence crops. As indicated in this empirical analysis, the nurturing role of womanhood, the consciousness of being a primary care-giver is reinscribed through both paid and unpaid household production. Usually, women are officially employed in activities closely associated with feminine roles, such as nurseries, book-keeping offices, and social work. The gender division of labor occurs at all sites of work, paid or unpaid. There is no particular origin to its structuring because it emerges at all scales and sites of production simultaneously, from state policies, to farming practices, to household chores.

The above gendered processes contribute to a contradictory relationship between cropping system and fertilizer input. This is manifest principally in soils within subsistence parcels and obscured in commercial plots. Masculinity, in this context, is associated with surplus crop production that leads to greater nutrient demands. Yet the subsistence cropping systems ("kitchen vegetables") based on women's and/or shared decisions result in less fertilizer demand. Gendered differences in soil use erupt in a contradiction between soil additions and cropping system demands that result in excessive fertilizer application so that the environmental impact of gendered subsistence farming practices is not necessarily less ecologically disruptive than those pertaining to large-scale farming. In cash-crop production, the contradiction is avoided through the (socially enforced) absence of women in nearly all aspects of production, but the negative ramifications for soil quality are even more severe. Gender relations within each family production situation vary, but express this general contradictory tendency that features men, trained in growing more nutrient-demanding crops, contributing excessive fertilizer relative to lower nutrient-demanding crops, which are chosen by women to provide for their kitchens. Without considering the gender relations affecting soil use, the causes of excessive fertilizer applications in subsistence parcels, an additional source of stream eutrophication, would remain opaque.

Conclusions

While intrinsic soil properties and the outcomes of previous cropping systems constrain households' current soil management practices, soil conditions not only have

different gendered effects in each household, but they are themselves shaped by past and present gender relations. The tendency of similar soil types to feature wide differences associated with gendered cropping type suggests that differences in soil property cannot by themselves serve an explanatory function. Place-specific gender divisions of labor and property relations affect soil management directly and thereby shape anthropogenic soil quality shifts. It is mostly male farmers who are engaged in such practices. Women's greater control over subsistence vegetable production results in the planting of typically less nutrient-extracting crops or of less overall nutrient demands due to the greater biodiversity and smaller scale of the operation. The lower inputs characterizing subsistence parcels usually stem from a lack of women's control over farming equipment and decisions regarding the distribution of anthropogenic soil additions. This division of labor and resource access results in a contradiction between masculinized cash-crop scale soil additions and feminized subsistence-crop soil nutrient extraction. This tendency is manifest through the results of the interviews and the environmental practices of the above described households. Property relations affect current agricultural practices and soil use in that most farmers who have had land returned from the local co-operative farm are men. Some women have received land as inheritance from fathers or grandfathers, but as the only surviving progeny. Typically, women lose control over their land as a result of farming inexperience brought about through the gender division of labor, which separates subsistence from cash-crop production.

Since 1991, state extension services and soil monitoring have diminished as they have become the province of private consulting agencies. As a result, conventional farming practices continue on smaller land parcels with little environmental impact assessment. As they try to keep productivity high to fetch sufficient income, some Ormánság farmers tend to exaggerate fertilizer applications and/or remove more minerals than they return to the soil. It is important therefore to consider gender relations not only to provide more encompassing explanations of anthropogenic soil change, but also to devise more effective soil conservation measures. This case study provides one way of considering social relations to enhance explanations of how and why people manage soils in ways that can lead to either (anthropocentrically speaking) positive or deleterious changes in soil properties, which affect both local food provisioning levels and interconnections with processes at larger social scales.

While an exploration of the multiple physical and social scales involved must be postponed to future research, it should be borne in mind that gendered shifts in soil management are contingent on larger-scale (gendered) social and environmental processes. For instance, the opportunity for a male farmer to introduce watermelon into the Ormánság successfully in the mid 1980s resulted from the combination of world economic shifts. Among other factors, the dissipation of Soviet state influence in Hungary and the resulting greater linkage to western European economies coincided with a gradual reduction of state involvement in the direct management of farms. These global and regional dynamics reverberated within Hungarian society through, for example, the emergence of a male technocratic elite, gender-biased agronomic training institutions, the partial privatization of agriculture since the 1968 reforms, and greater linkages with neighboring western markets since the late 1970s. Just as important, physical environment factors provided the sufficient conditions for watermelon production

through a submediterranean climate with relatively high summer rainfall, large tracts of flat floodplain land, and the occurrence of soils with adequate Mg and Cu levels. These social and ecological processes and their conjuncture at multiple scales enabled the appearance of watermelon as a viable crop in SW Hungary under predominantly male initiative and control. The spread of watermelon cultivation affects soil management and eventually soil characteristics at the detailed scale.

Understanding the conjuncture-specific effects of gender relations on soil quality change has important implications for soil geography, soil conservation policies, and the integration of egalitarian social ends with the nature of environmental change. For greater precision and accuracy in describing and explaining the development and distribution of soils, gender relations must become part of soil analysis as a causal pedogenic process for short-term and detailed scale change. For effective implementation, the social roles of the people affected by soil conservation measures must be taken into account, as others have already ably demonstrated, and this includes gender roles (e.g., Rocheleau, Thomas-Slayter, and Wangari, 1996; Schroeder, 1999). Finally, the understanding of the context-dependent connections between gender relations and anthropogenic soil quality change can attune the analysis of environmental processes with struggles for social egalitarianism so that nonhuman processes, rather than being reduced to the products of social relations, are considered as integral factors shaping social processes and possibilities.

Notes

¹ There would be seemingly great promise for the development of a truly transdisciplinary perspective on this issue (Zimmerer and Bassett, 2003: 16), given the vast literature available on, for instance, the geography and formation of soils, soil-plant relations, soil quality indices, sustainable agriculture, rural livelihoods, agrarian transformations, agroecological processes, and so on. Unfortunately, collaboration among social and physical scientists continues to be rare, to the detriment of a fuller explanation of soil degradation processes. This is not solely due to the sometimes reciprocally inscrutable languages and methods used in scientific fields resulting from the fragmentation of the sciences and attendant compartmentalisation in research funding opportunities, but also to different knowledge production systems and infrastructures as well as seldom discussed differences in political commitments, which may be more important (see Nigel Thrift's contribution in Harrison et al., 2004). This is especially regrettable as major advances in understanding the causal mechanisms of social processes behind soil quality change have occurred since the 1980s. Equally unfortunate is the exiguous attention paid by most social scientists to advances in the study of physical processes, which help discern nonhuman agency and enrich the understanding of causal mechanisms, such as through non-equilibrium approaches and the consideration of intrinsic soil dynamics (Phillips, 2001; Zimmerer and Young, 1998).

² With further research, the study will be contextualized in wider social and ecosystem processes, such as EU membership and regional climatic shifts. At present, the author does not have sufficient information to make such linkages, though some rough outlines

can already be discerned through interviews and secondary data; future work will focus on multiple-scale dynamics.

³ Soil scientists have even devised a special analytical category, anthropic soils or anthrosols, to recognise the strong and long-lasting pedogenic effects of human activities (Denevan, 2001; Evans, Fanning, and Short, 2000).

⁴ The acronym stands for *Agrokémiai Információs és Irányítási Rendszer* (Agrochemical information and control system).

⁵ Counting all the members of the households and families that are related to the interviewees, the interview results reflect the economic situation for 115 people (0.6 percent of the total population).

⁶ The average and standard deviation seem to make the sample reasonably representative of most households in the area. According to a 1995 survey by the Ormánság Development Association, covering about 51 percent of owned arable land, there is a pyramidal structure to land distribution reminiscent of pre-1948 figures, with 77 percent of farm operators possessing less than 20 ha. There are no such studies on the ownership distribution of subsistence plots, but they are nearly ubiquitous (Kolyris, 1995).

⁷ The names of the families have each been assigned a letter so as to ensure privacy. Plots on the farming co-operative belong to an absentee landlord who rents his land to a privatized co-operative under male management, whereas the other parcels are used by a local non-profit organization engaged in cash-cropping systems using alternative, low-input agriculture techniques. These also include three subsistence plots owned by a member of the organization that are used as part of the overall larger-scale operation; hence their exclusion from this discussion. Upper and lower level employees were interviewed from the farming co-operative and non-profit organization about internal divisions of labor.

⁸ Table 2 focuses only on chemical indicators, since soil biological and physical properties could not be determined in this study, owing to research funding limitations.

⁹ According to the 1995 Ormánság Development Association survey, men have 87% of land titles; however, 25% of the families I interviewed remarked that titles were held under the names of both spouses, so the Ormánság Development Association survey may not be representative.

¹⁰ High phosphate content can lead to eutrophication, a form of pollution of streams and lakes through down-slope transfers.

¹¹ Yield had decreased from 4 t/ha in 1996 to 2 t/ha 1997, which was due to above-average precipitation during the growing season (triticale is humidity-sensitive).

¹² CaCO_3 and Mg indicate potential amounts, as major nutrients, available to plants, but also point to the extent to which crops can be protected from toxic elements, like Mn and Al, and the degree to which soils can be buffered from changes in pH (the higher, the more buffered).

¹³ Mn content, not shown on Table 3 for lack of space, can also indicate pH effects indirectly, as Mn becomes toxic to plants at $\text{pH} < 5.5$ (Ellis and Mellor, 1995: 191; Menzies, 2003: 272). Lower crop yield in the commercial plots may be due to relatively high Mn levels (90-141 ppm) compared to values for the subsistence plot (18 ppm).

¹⁴ NO₃, though present in manure, is more readily made available to plants, but can be leached out of soils more easily (see also Barak et al., 1997).

¹⁵ He insists on using such chemicals because he sees no other way of ensuring income except by maximising yield, even if he was hospitalised for liver damage due to biocide exposure in the 1980s. Conforming to male roles can have deleterious repercussions for the individual directly involved, as well as the rest of the family and soil conditions. Were Mr. A's health to deteriorate, not only family roles would be modified, but, given Ms. A's family role and employment, commercial plots would probably have to be either rented out or abandoned, which entails changes in cropping system and land management.

¹⁶ The land title, acquired through compensation, was transferred from Mr. B to his son apparently to avoid higher property taxes. The rent is distributed among a variety of household and farming expenses.

¹⁷ This may be due to low soil buffering capacity (i.e., low content of acidity-buffering minerals) and a dearth of Ca-bearing minerals, so that lime Ca was readily dissolved, but more mineralogical analysis is necessary for interpretation.

¹⁸ Ms. C has been involved with a local NGO in the past and since then learned of the effects of biocides. She ceased to participate in the foundation's programs, however, because she never received any help or funds in establishing organic production methods. Regardless, it is due to Ms. C that no biocides are used in the family farm subsistence and commercial operations.

¹⁹ The factory produces for transnational western European firms through short-term subcontracting.

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Table 1. General soil quality indicators (ppm is parts per million)

Indicator	Soil functions	Range	Optimum
pH	Maintaining fertility and healthy biota	5.5-8.2	6.5
Calcium carbonate (CaCO ₃)	Buffering against acidity, health of biota, nutrient cycling	1-10 %	3-5 %
Organic matter (OM)	Fertility, aeration, temperature moderation, moisture flow and storage, health of biota, etc.	1-5 %	n.a.
Nitrate nitrogen (NO ₃)	Health of biota, nutrient cycling	3-50 ppm	25 ppm
Phosphorus (P ₂ O ₅)	Health of biota, nutrient cycling	7.5-150 ppm	30 ppm
Potassium (K ₂ O)	Health of biota, nutrient cycling	45-525 ppm	170 ppm
Magnesium (Mg)	Buffering against acidity, health of biota, nutrient cycling	100-500 ppm	n.a.

Source: adapted partially from Mausbach and Seybold, 1998: 38, and partially deduced and approximated from Baranyai et al., 1987: 28-29.

Table 2. Family farm A: cropping system, yield, and soil conditions

Year	Crop	Area	Yield	pH	CaCO₃	OM	NO₃	P₂O₅	K₂O	Mg
		ha	t/ha		-----%-----			-----ppm-----		
Commercial plot										
1985	Maize	35	29	5.75	0.0	1.67	148	97	151	190
1990	Maize	35	17	6.50	0.1	1.79	n.a.	92	133	299
1998	Maize	3	4.6	5.48	0	1.51	3	795	202	69
1998	Triticale	3	4.0	5.17	0	1.28	6	185	168	103
Subsistence plot										
1998	Mixed	0.04	n.a.	7.53	5	3.20	8	2175	528	146

Table 3. Family farm B: cropping system, yield, and soil conditions

Year	Crop	Area	Yield	pH	CaCO ₃	OM	NO ₃	P ₂ O ₅	K ₂ O	Mg
		ha	t/ha		-----%-----			-----ppm-----		
1.9 ha commercial plot, near house										
1984	wheat	16	8	7.58	n.a.	2.00	91	191	107	115
1988	winter barley	16	5.7	7.17	1.8	1.72	n.a.	191	107	115
1998	oats	1.9	0.4-0.6	4.82	0	1.33	7	287	200	47
Subsistence plot, near house										
1998	mixed	0.02	n.a.	5.69	0	1.55	11	540	147	111
Six ha commercial plot										
1985	wheat	31	13	5.21	0	1.71	161	118	197	292
1991	maize	42	1.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1998	oats	2	n.a.	5.97	0	1.47	6	218	177	138
1998	maize	2	≤10	7.07	0	1.32	12	207	160	131
1998	maize	2	≥5	5.71	0	1.36	5	184	146	125

Table 4. Family farm C: cropping system, yield, and soil conditions

Year	Crop	Area	Yield	pH	CaCO ₃	OM	NO ₃	P ₂ O ₅	K ₂ O	Mg
		ha	t/ha		-----%-----			-----ppm-----		
Commercial plot										
1982	Wheat	38	18	n.a.	0	1.73	n.a.	70	144	n.a.
1984	Wheat	38	17	n.a.	0	1.17	11.3	229	162	128
1985	Peas	38	13	4.80	0	1.17	11.3	229	162	128
1986	Winter wheat	38	4	4.80	0	1.17	n.a.	229	162	128
1987	Silo maize	38	17	4.80	0	1.17	n.a.	229	162	128
1988	Silo maize	38	20	5.59	0	1.51	n.a.	109	191	151
1989	Maize	41	7	5.59	0	1.51	n.a.	109	191	151
1990	Maize	41	17	5.59	0	1.51	n.a.	109	191	151
1991	Fall wheat	1	n.a.	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.
1996	Watermelon	5	28	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1998	Watermelon	1	30	5.82	0	1.02	6	1362	337	82
1998	Watermelon	4	30	6.29	0	1.26	7	1085	348	110
Subsistence plot										
1998	Mixed	0.01	n.a.	6.96	0	1.34	12	1849	557	137